REMARKS/ARGUMENTS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 6-10, 13-17 and 21-22 are pending in the present application. Claims 6, 8, 10, 13, 15 and 17 have been amended, Claims 1-5, 11, 12 and 18-20 have been canceled without prejudice, and Claims 21 and 22 have been added by the present amendment.

In the outstanding Office Action, the drawings were objected to; Claims 1, 3 and 4 were rejected under 35 U.S.C. § 102(b) as anticipated by Kumar (U.S. Patent No. 5,861,707); Claims 1 and 2 were rejected under 35 U.S.C. § 102(b) as anticipated by Patterson et al. (U.S. Patent No. 6,441,550); Claims 6, 9 and 10 were rejected under 35 U.S.C. § 103(a) as unpatentable over Nakamura et al. (U.S. Patent No. 6,281,626) in view of Kumar; Claims 6-8, 11-13 and 19 were rejected under 35 U.S.C. § 103(a) as unpatentable over Nakamura et al. in view of Patterson et al.; Claims 13, 16, 17 and 20 were rejected under 35 U.S.C.§ 103(a) as unpatentable over Jin et al. (U.S. Patent No. 5,982,095) in view of Kumar; and Claims 13-15, 18 and 20 were rejected under 35 U.S.C. § 103(a) as unpatentable over Jin et al. in view of Patterson et al.

Regarding the objection to the drawings, Figure 1 has been modified in light of the comments noted in the outstanding Office Action. A replacement drawing is included. Accordingly, it is respectfully requested this objection be withdrawn.

Regarding the rejection to Claims 1, 3 and 4 under 35 U.S.C. § 102(b) as anticipated by Kumar and the rejection to Claims 1 and 2 under 35 U.S.C. § 102(b) as anticipated by Patterson et al., Claims 1-4 have been canceled without prejudice. Accordingly, these rejections are moot.

Claims 6, 9 and 10 were rejected under 35 U.S.C. § 103(a) as unpatentable over Nakamura et al. in view of Kumar. That rejection is respectfully traversed.

Amended independent Claim 6 is directed to a cold cathode discharge device used as a discharge lamp that includes an envelope filled with a discharge gas therein, and a cold cathode positioned in the envelope. The cold cathode includes a supporting member of conductive material and an electron emitter with an electron-emitting surface to emit electrons supported by the supporting member. The electron emitter includes a mixed phase of diamond phase and conductive carbon phase. Further, the conductive carbon phase extends in the form of a channel between the supporting member and the electron-emitting surface in the electron emitter. Finally, the discharge gas includes a rare gas and mercury.

In a non-limiting example, Figure 1 illustrates that a discharge lamp with an elongated envelope 10 is discharged by the electrons emitted from cold cathodes (19 and 20) located in the elongated envelope 10. Also, as shown, the cold cathodes (19 and 20) are very small compared to an electric discharge volume of the elongated envelope 10.

The electron emitting efficiency of a cathode significantly affects the luminescence characteristic of the cold cathode discharge lamp. The luminescent efficiency of a cold cathode type discharge lamp is lower than that of a hot cathode type discharge lamp because the voltage drop in front of the cathode (cathode drop voltage) is almost ten times larger than that of a hot cathode type lamp. Because the luminescence efficiency is the most important feature of a lamp device, reducing the cathode drop voltage is strongly desired. In addition, low-field electron emitters in a discharge lamp device are not applicable for this use because the envelope is filled with a conductive plasma during discharge, and therefore field emission is not a main issue for electron emission. Instead, a secondary electron emission is useful in reducing the cathode drop voltage. Diamond is considered a potential material for a cold cathode of a discharge lamp because diamond has a large secondary electron emission. However, diamond also has a large resistance generally, and thus is not suitable for the actual cold cathode.

The claimed invention provides a cold cathode that contains a conductive carbon channel that extends into a diamond layer. This configuration lowers the resistance of a cold cathode that includes diamond and remarkably reduces the cathode drop voltage. Additionally, the cold cathode of the claimed invention enables a uniform electric discharge to almost all of the code cathode surface. Further, a uniform conductance is supplied by the conductive carbon channel because almost all of the surface of the cold cathode is covered with diamond, which is extremely suitable for secondary electron emission. Also, a diamond structure is efficient for a long life because diamond has an extremely high sputtering resistance for rare-gases. Thus, the claimed invention provides an improvement to the luminescence efficiency and the life of a cold cathode discharge lamp.

Kumar and Patterson et al. do not teach or suggest a cold cathode discharge device used as a discharge lamp. That is, the cathode of Kumar and Patterson et al. are applied in a vacuum and do not teach or suggest any application with a discharge lamp nor the problems peculiar to the discharge lamp. Nakamura et al. also do not disclose the cold cathode structure of diamond and its particular action and effect of the claimed invention.

Additionally, the dependent claims of the claimed invention further define over the applied art for additional reason now discussed. Dependent Claims 7 and 14 recite that the discharge gas includes xenon. The luminescence wavelength of xenon (Xe) gas is suitable for efficiently exciting diamond. Thus, the characteristics of a discharge lamp that includes diamond may be enhanced remarkably using Xe gas. Further, the diamond phase of an electron emitter of the claimed invention has sufficient sputtering resistance for Xe, thereby maintaining the long life of the cold cathode discharge lamp.

Accordingly, it is respectfully requested this rejection be withdrawn.

Further, it is respectfully submitted the secondary references of Patterson et al. and Jin et al. also do not teach or suggest the claimed invention. Accordingly, it is respectfully requested the additional rejections be withdrawn for similar reasons as discussed above.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Eckhard H. Kuesters
Attorney of Record
Registration No. 28,870
David A. Bilodeau
Registration No. 42,325

Customer Number
22850

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 08/03)

EHK:DAB:KLL:tdm
I:\ATTY\KLL\PROSECUTION\22's\220662US\220662US AM 8.25.03 OA.DOC

Docket No.: 220662US2TTCRD

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION: Tadashi SAKAI et al.

SERIAL NO.: 10/098,571 GAU: 2879

FILED: March 18, 2002 EXAMINER: COLON, GERMAN

FOR: COLD CATHODE AND COLD CATHODE DISCHARGE DEVICE

LETTER SUBMITTING DRAWING SHEET(S)

COMMISSIONER FOR PATENTS
Alexandria, VA 22313

SIR:

Responsive to the below indicated communication, the following drawing sheets are submitted herewith:

■ 1 Replacement Drawing Sheets ☐ ____ New Drawing Sheets

■ Official Action dated August 25, 2003

☐ Notice of Allowance/Issue Fee dated _____

☐ Other dated _____

The changes and/or modifications made include the following:

Figure 1, left reference numerals 18 and 16 have been changed to 15 and 17 respectively.

Respectfully submitted,

Eckhard H. Kuesters
Attorney of Record
Registration No. 28,870
David A. Bilodeau
Registration No. 42,325

Customer Number
22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 05/2003)